Ministry of Education and Science of Ukraine
Ivan Franko National University of Lviv
Faculty of Electronics and Computer Technologies
Department of Radiophysics and Computer Technologies

Approved
Department of Radiophysics and Computer Technologies of Ivan Franko National University of Lviv
(meeting minutes #12/23 from June 20, 2023)

Head of Department _____ Ivan KARBOVNYK

Academic Discipline Syllabus

"Internet of Things"

which is taught within the Education Program «Computer Science»

for the second (master) higher education level

in the Specialty 122 – Computer Science

Lviv 2023

Discipline	Internet of Things
Address	107 Tarnavskyi Street, 79017 Lviv, Ukraine
Faculty	Faculty of Electronics and Computer Technologies
Branch of science	12 Information Technologies, 122 Computer Sciences
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Consulting resources	Consultations on the day of lectures (by prior arrangement) are possible: Room 310, Faculty Building 107, Tarnavskyi Street, Lviv. Online consultations via the MS Teams or Moodle e-learning systems are available as an option. Consultation times can be scheduled online by emailing the instructor.
Discipline page	https://moodle.elct.lnu.edu.ua/course/view.php?id=104 https://electronics.lnu.edu.ua/course/internet-of-things-122-kn
Discipline information	"Internet of Things (IoT)" is the discipline of choice, which involves 180 hours in total, including 32 hours of lectures, 32 hours of laboratory works, and 116 hours of self-practice. It is a multidisciplinary field that explores the interconnectedness of devices and objects through the internet. It encompasses the study of various technologies, protocols, and applications that enable everyday objects to collect, exchange, and analyze data for improved functionality and efficiency. Students in IoT courses typically learn about sensor networks, data analytics, cloud computing, cybersecurity, and the practical implementation of IoT solutions across various industries, such as healthcare, transportation, agriculture, and smart cities. This discipline equips students with the skills to design, develop, and manage IoT systems, making them well-prepared for a wide range of career opportunities in the rapidly evolving world of IoT technology.
Abstract	"Internet of Things (IoT)" is a multidisciplinary field that explores the interconnectedness of devices and objects through the internet. It encompasses the study of various technologies, protocols, and applications that enable everyday objects to collect, exchange, and analyze data for improved functionality and efficiency. Students in IoT courses typically learn about sensor networks, data analytics, cloud computing, cybersecurity, and the practical implementation of IoT solutions across various industries, such as healthcare, transportation, agriculture, and smart cities. This discipline equips students with the skills to design, develop, and manage IoT systems, making them well-prepared for a wide range of career opportunities in the rapidly evolving world of IoT technology.
Goal and objectives	The ultimate goal is to provide students with a comprehensive understanding of the Internet of Things (IoT) concept, principles, and technologies. Objectives are the following: Fundamental Concepts: To teach students the fundamental concepts of IoT, including sensor technologies, data communication, and device integration. Technical Skills: To develop practical skills in students, enabling them to build IoT systems, program IoT devices, and analyze IoT-generated data. Interdisciplinary Integration: To facilitate the integration of knowledge from

	different disciplines, enabling students to design holistic IoT solutions. Problem-Solving: To enhance students' problem-solving skills, enabling them to identify and resolve issues in IoT system design and implementation. Security Awareness: To educate students about IoT security risks and strategies for safeguarding IoT ecosystems from potential threats. Project-Based Learning: To engage students in hands-on, project-based learning experiences that simulate real-world IoT development scenarios. Ethical Considerations: To encourage ethical considerations in IoT design, emphasizing responsible data handling and privacy protection. Industry Relevance: To align the curriculum with industry trends and standards, ensuring graduates are well-prepared for careers in the IoT field. Innovation: To inspire students to innovate and propose novel IoT solutions that can address contemporary challenges and improve quality of life. Communication Skills: To enhance students' communication skills, enabling them to effectively convey IoT concepts and solutions to diverse audiences.
References	1. Shacham, N. (2017). "Internet of Things with ESP8266." Packt Publishing. 2. Atzori, L., Iera, A., & Morabito, G. (2010). "The Internet of Things: A Survey." Computer Networks, 54(15), 2787-2805. 3. Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). "Internet of Things (IoT): A vision, architectural elements, and future directions." Future Generation Computer Systems, 29(7), 1645-1660. 4. Kortuem, G., Kawsar, F., Sundramoorthy, V., & Fitton, D. (2010). "Smart objects as building blocks for the Internet of Things." IEEE Internet Computing, 14(1), 44-51. 5. Vermesan, O., & Friess, P. (2013). "Internet of Things: Converging technologies for smart environments and integrated ecosystems." River Publishers. 6. Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). "Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications." IEEE Communications Surveys & Tutorials, 17(4), 2347-2376. 7. Ashton, K. (2009). "That 'Internet of Things' Thing." RFID Journal, 22(7), 97-114.
Teaching duration	180 hours total, 64 hours of classroom sessions, including 32hours of lectures, 32 hours of hands-on trainings, and 116 hours of self-education
Expected results	Expected results for students who have successfully completed an IoT course: - comprehensive knowledge: students should have a comprehensive understanding of IoT concepts, principles, and technologies, including sensor networks, data communication protocols, and IoT architecture. - technical skills: Graduates should possess practical technical skills related to designing, developing, and implementing IoT solutions, such as programming microcontrollers, setting up sensors, and working with IoT platforms. - interdisciplinary integration: students should be able to integrate knowledge from various disciplines, such as computer science, electronics, and data science, to create holistic IoT solutions. - problem-solving abilities: graduates should have enhanced problem-solving abilities, enabling them to identify and troubleshoot issues in IoT system design and operation. - cybersecurity awareness: graduates should be aware of IoT security risks and be capable of implementing security measures to protect IoT systems and data.

	- innovation and creativity: Students should be encouraged to think innovatively and creatively, proposing novel IoT solutions and applications that address real-world challenges. - project experience: graduates should have practical project experience, having worked on IoT projects that simulate real-world scenarios, demonstrating their ability to apply IoT concepts. After studying the course, applicants will acquire the following competencies (ZK, SK) and program results (PH): ZK1. Ability to abstract thinking, analysis and synthesis. ZK7. Ability to generate new ideas (creativity). SK5. Ability to develop, describe, analyze and optimize architectural solutions of information and computer systems for various purposes. SK6. Ability to apply existing and develop new algorithms for solving problems in the field of computer science. SK7. Ability to develop software according to formulated requirements, taking into account available resources and constraints. SK8. Ability to develop and implement software development projects, including in unpredictable conditions, with unclear requirements and the need to apply new strategic approaches, use software tools to organize teamwork on the project. SK10. The ability to evaluate and ensure the quality of IT projects, information and computer systems of various purposes, to apply international standards for assessing the quality of software of information and computer systems, models for evaluating the maturity of information and computer systems development processes. SK11. Ability to initiate, plan and implement the development processes of information and computer systems and software, including its development, analysis, testing, system integration, implementation and support. SK12. The ability to combine software approaches with optimal hardware solutions and basic knowledge of electronics in the creation of intelligent, high-level embedded and specialized computer systems. SK13. Ability to apply methods and approaches of artificial intelligence, intellectual analysis and data science and optimization approaches to solving specific computer science problems. PH1. Have specialized conceptual knowledge that includes modern scientific achievements in the field of computer science and is the basis for original thinking and conducting research, critical thinking of problems in the field of computer science and at the border of the fields of knowledge. PH2. Have specialized computer science problem-solving skills necessary for conducting research and/or conducting innovative activities to develop new knowledge and procedures. PH3. It is clear and unambiguous to convey one's own knowledge, conclusions and arguments in the field of computer science to specialists and non-specialists, in particular to persons who are studying. PH4. Manage work processes in the field of information technologies, which are complex, unpredictable and require new strategic approaches. PH5. Evaluate the results of teams and collectives in the field of information technologies, ensure the effectiveness of their activities. PH6. Develop a conceptual model of an information or computer system. PH10. Design architectural solutions of information and computer systems for various purposes. PH11. Create new algorithms for solving problems in the field of computer science, evaluate their effectiveness and limitations on their application.

	PH13. Assess and ensure the quality of information and computer systems for various purposes. PH14. Test the software. PH15. Identify the needs of potential customers regarding the automation of information processing. PH17. Identify and eliminate problematic situations during software operation, formulate tasks for its modification or reengineering. PH18. Collect, formalize, systematize and analyze the needs and requirements for the information or computer system being developed, operated or supported. PH19. To analyze the current state and global trends in the development of computer sciences and information technologies. pH 20. To have the methods and means of artificial intelligence, engineering and data analysis, pattern recognition and adaptive processing of information, analysis and processing of natural language, modeling and optimization. PH21. Create new data systems, high-level embedded systems, specialized computer systems and intelligent systems using basic knowledge of hardware and software of microcontrollers and microcomputers.
Key words	Smart devices, Cloud computing, Edge, IoT protocols, MQTT, JSON
Course format	In-person
Topics	See course scheme
Knowledge control	Exam
Pre-requisites	Basic programming skills: A foundational understanding of programming is essential. Students should be familiar with at least one programming language, such as Python, C++, or Java. Networking concepts: understanding of basic networking concepts like IP addressing, protocols (e.g., TCP/IP), and network topologies. Electronics: some IoT courses may require a basic understanding of electronics, including knowledge of components like resistors, capacitors, and microcontrollers. Mathematics: knowledge of mathematics, particularly algebra and calculus, may be necessary for understanding certain IoT concepts.
Teaching methods and techniques	Presentations, lectures, hands-on trainings, workshops
Equipment	Multimedia platform (Moodle), hardware and software: Arduino Integrated Development Environment, MQTTX Client Toolbox
Assessment criteria	Assessment is conducted throughout the semester on a 100-point scale. Points are awarded for the following types of work with the following distribution: Practical assignments: 50% of the semester grade; maximum of 50 points (8 practical assignments, where 2 additional points are given for the quality completion of all assignments). Midterm exams (2 modules): 50% of the semester grade; a maximum of 50 points. Grades for practical sessions are distributed as follows: completion of practical tasks - 60%, answers to the teacher's questions on the topic of the session - 40%. Midterm assessments are conducted in the form of test assignments, with 25 points allocated for each module.

	Academic Integrity: it is expected that students' practical and assessment work will constitute their original research or reasoning. The absence of references to used sources, source fabrication, plagiarism, interference with the work of other students, while not limited to these, are examples of possible academic misconduct. The identification of signs of academic misconduct in a student's work is grounds for its non-recognition by the instructor, regardless of the scale of plagiarism or deception.
Self-control questions	Self-control questions list can be found on Moodle https://moodle.elct.lnu.edu.ua/course/view.php?id=104).
Questionary	A course evaluation questionnaire with the purpose of assessing the course's quality will be provided upon the course's completion.

Course scheme

Week	Topic and abstract	Form	References	Hands-on and self-education tasks	Tasks due
1	Introduction to IoT: An overview of IoT concepts, evolution, and its impact on various industries.	Lecture	1	Introductory session	Week 1
2	IoT Architecture: Exploring the layered architecture of IoT systems, including devices, communication, and application layers.	Lecture	1	Working with basic IoT setup	Week 2
3	IoT Communication Protocols: An in-depth look at communication protocols like MQTT, CoAP, and HTTP used in IoT.	Lecture	1	Working with MQTT in an IoT setup	Week 3
4	IoT Sensors and Actuators: Understanding the role of sensors and actuators in IoT, their types, and applications.	Lecture	2	Working with HTTP in an IoT setup	Week 4
5	Wireless Technologies for IoT: Exploring wireless communication technologies like Wi-Fi, Bluetooth, LoRa, and 5G for IoT connectivity.	Lecture	2	Wi-Fi provisioning and device onboarding	Week 5
6	IoT Data Management: Strategies for collecting, storing, and processing large volumes of data generated by Io	Lecture	3	Understanding AWS IoT Core and related services	Week 6
7	IoT Security and Privacy: Discussing security challenges in IoT and methods to secure IoT	Lecture	4	Working with tokens and certificates	Week 7

	devices and data				
8	Edge Computing in IoT: The concept of processing data at the edge of the network for reduced latency and improved efficiency.	Lecture	5	Understanding AWS Greengrass	Week 8
9	IoT Platforms and Frameworks: An overview of IoT development platforms and frameworks for building IoT applications.	Lecture	5	Simple platforms: Arduino IoT Cloud	Wekk 9
10	Smart Cities and IoT: How IoT is transforming urban environments, enhancing infrastructure, and improving quality of life.	Lecture	6	Advannced platforms: ThingSpeak	Week 10
11	IoT in Agriculture: Understanding the role of IoT in precision agriculture, smart farming, and crop monitoring.	Lecture	6	Working with LoRa technology	Цуул 11
12	IoT in Industrial Automation: Examining how IoT is used in Industry 4.0, including predictive maintenance and process optimization.	Lecture	1,3	Examples of vibrational diagnostics in IoT domain	Week 12
13	IoT and Environmental Monitoring: Applications of IoT in tracking and managing environmental factors such as air quality and water resources.	Lecture	1, 2	Designing multisensor IoT systems	Week 13
14	IoT and Wearable Technology: Exploring wearable IoT devices and their impact on health, fitness, and consumer applications.	Lecture	7	Working with wearable device prototype	Week 14
15	IoT in Healthcare: Exploring applications of IoT in healthcare, including remote monitoring and telemedicine.	Lecture	7	Working with medical IoT devices	Week 15
16	IoT Use Cases and Case Studies: Examining real-world examples and case studies showcasing successful IoT implementations across various industries.	Lecture	1	Conclusing session	Week 16