COURSE DESCRIPTION

General information		
Lead instructor	Associate Professor Borut Lužar Assistant Professor Ivan Tomljenović	
Course name	**CDS-19: Internet of things, sensors and geoinformation systems**	
Study programme	**Computer and Data Science, third cycle Doctoral Study Programme**	
Course status	Optional	
Year	First or Second	
Number of credits and mode of delivery	ECTS student workload coefficient	10
	Number of hours (L+P+S)	30/-/270

Course description
1.1. Course goals
Provide a comprehensive understanding of the IoT ecosystem, including sensor technology, communication protocols, and data analytics. Explore advanced concepts and methodologies in geoinformation systems and their application in IoT. Develop critical skills for designing and deploying sensor networks and IoT solutions. Foster expertise in handling, analyzing, and visualizing geospatial data. Encourage innovation and research in the integration of IoT and geoinformation systems. Prepare students for advanced research and leadership in academia or industry within this specialized field.
1.2. Course enrolment requirements
Elementary knowledge of IoT fundamentals
1.3. Intended course learning outcomes
Mastery of IoT Ecosystems and Sensor Technologies: Gain comprehensive knowledge of IoT architectures, various sensor technologies, and their applications. Understand and articulate the principles of IoT ecosystems, including sensor types, functionality, and deployment strategies in different contexts. Advanced Proficiency in Geoinformation Systems: Develop expertise in Geographic Information Systems (GIS) and remote sensing technologies. Acquire the ability to apply advanced geospatial data analysis and modeling techniques, contributing to the field of geoinformatics with innovative approaches and solutions. Integration Skills for IoT and Geospatial Data: Learn to effectively integrate IoT technology with geoinformation systems. Demonstrate the capability to design and implement solutions that combine real-time data acquisition from IoT sensors with spatial analysis, addressing complex environmental, urban, or social challenges.

Expertise in Data Analytics and Visualization:
Acquire skills in advanced data analytics, specifically pertaining to large datasets generated by IoT devices and geospatial sources. Become proficient in employing visualization techniques and machine learning algorithms to interpret IoT and geospatial data, making informed decisions based on these analyses.

Research and Innovation in IoT and GIS:
Develop a strong foundation in research methodologies relevant to IoT and GIS. Demonstrate the ability to conduct significant, original research that advances the field, and propose innovative solutions to real-world problems through the application of IoT and geoinformation technologies.

1.4. *Course content*

Fundamentals of IoT and Sensor Technologies:

Overview of IoT architecture and ecosystems.
In-depth study of sensor technologies and their applications.
Communication protocols and data transmission in IoT networks.
Advanced Geoinformation Systems:

Geographic Information Systems (GIS) technologies and spatial data analysis.
Remote sensing and satellite imagery analysis.
Advanced spatial data modeling and geostatistics.
IoT and Geoinformation System Integration:

Methods for integrating IoT with geospatial data.
Real-time data acquisition and processing.
Case studies on smart cities, environmental monitoring, and more.
Data Analytics and Visualization in IoT:

Big data analytics in IoT.
Visualization techniques for geospatial and IoT data.
Machine learning and AI applications in IoT and GIS.
Research Methodologies in IoT and Geoinformation Systems:

Qualitative and quantitative research methods.
Experimental design and case study methodology.
Ethical considerations and data privacy in IoT and GIS research.
Innovation and Future Trends:

Emerging technologies in IoT and geoinformation systems.
Cross-disciplinary applications and future directions.
Challenges and opportunities in IoT and GIS integration.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ *lectures* ☐ *seminars and workshops* ☒ *practicals* ☐ *remote learning* ☐ *field work*	☒ *independent work* ☐ *multimedia and network* ☐ *laboratory* ☐ *supervision* ☐ *other* _____

1.6. Student obligations

1.7. Monitoring student work (mark the appropriate boxes with an X)

Class attendance		Participation in class		Seminar paper		Experimental work	
Written exam		Oral exam		Essay		Research	
Project		Continuous assessment of knowledge		Student report		Practical work	
Portfolio		Schoolwork		Homework			

1.8. Assessment and evaluation of student work during classes and the final exam

Type (examination, oral, coursework, project):

- Regular submission of research critiques and literature reviews, 40%
- Development and presentation of a research proposal, 60%

1.9. Required readings and number of copies relative to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Esposito, M., Palma, L., Belli, A., Sabbatini, L., & Pierleoni, P. (2022). Recent advances in Internet of Things solutions for early warning systems: A review. Sensors, 22(6), 2124. https://doi.org/10.3390/s22062124		
Krichen, M., Abdalzaher, M. S., Elwekeil, M., & Fouda, M. M. (2024). Managing natural disasters: An analysis of technological advancements, opportunities, and challenges. ScienceDirect. https://www.sciencedirect.com/		
Murodilov, K. T., & Numonov, J. O. (2023). Use of geo-information systems for monitoring and development of the basis of web-maps. Galaxy International Interdisciplinary Research Journal, 11(4). https://giirj.com/index.php/giirj/article/view/5108		
Janowicz, K., et al. (2020). GeoAI: A review of artificial intelligence approaches for the interpretation of complex geomatics data. _Geomatics Information*. https://gi.copernicus.org/		
Aldhaheri, A., Alwahedi, F., Ferrag, M. A., & Battah, A. (2024). Deep learning for cyber threat detection in IoT networks: A review. ScienceDirect. https://www.sciencedirect.com/		

1.10. Supplementary readings

- Atzori, L., Iera, A., & Morabito, G. (2010). The Internet of things: A survey. Computer Networks, 54(15), 2787-2805.

- Li, S., Xu, L. D., & Zhao, S. (2015). The internet of things: A survey. Information Systems Frontiers, 17(2), 243-259.
- Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). Geographic information science and systems (4th ed.). John Wiley & Sons.
- Rathore, M. M., Ahmad, A., Paul, A., & Rho, S. (2016). Urban planning and building smart cities based on the Internet of Things using Big Data analytics. Computer Networks, 101, 63-80.
- Zhou, K., Liu, T., & Zhou, L. (2015). Industry 4.0: Towards future industrial opportunities and challenges. 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD), 2147-2152.

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.