Course title	Blockchain and Cryptocurrencies				
Course code	IS505				
Type of lesson	Elective				
Level	Postgraduate				
Year / Semester	1st/2st				
ECTS	7.5	**Lectures / week**	1	**Workshops / week**	-
Course purpose and objectives	Blockchain technology has emerged as one of the most innovative technologies of the 21st century, with significant applications, but also intense debates about its usefulness and limitations. This course offers an in-depth analysis of the key concepts of Blockchain, starting with the birth of Bitcoin as the first cryptocurrency and examining the functioning of decentralized systems. At the same time, the question is critically approached: Is the Blockchain really the best solution for the problems it aims to solve? Through theoretical lessons, case studies and practical activities, students will explore: • The main features of Blockchain technology (decentralisation, immutability, transparency) • Real-life applications of Blockchain in various sectors, such as finance, supply chain, digital identity and voting • The relationship between Blockchain and cryptocurrencies and the technological principles underlying them. The limitations and challenges of the technology, such as scaling, energy consumption, legal and ethical implications. • Alternatives and comparisons with existing technologies, exploring whether Blockchain is always the most appropriate choice. The course promotes a critical and objective approach to Blockchain technology, encouraging students to evaluate its benefits and weaknesses. Through interdisciplinary approaches, they will be asked to analyze academic studies, examine data, and engage in discussions about the impact of the technology. As part of the semester, students will conduct research projects and study specific applications of Blockchain, coming to evidence-based conclusions. Thus, students who successfully complete the course will acquire fundamental knowledge about the operation of Blockchain and cryptocurrencies, critical analysis skills regarding the use and limitations of the technology, the ability to evaluate real use cases and compare them with alternatives, and finally practical experience through applied activities, case studies and laboratory exercises.				

	Upon successful completion of the course, students will be able to: 1. Describe the basic principles of Blockchain technology, such as network architecture, block structure, consensus algorithms and their applications. 2. Identify and explain how Bitcoin works, including its transactions, mining, security and economics. 3. Develop secure cryptocurrency wallets, explaining the use of public and private keys and how addresses work. 4. Evaluate different consensus algorithms, such as Proof-of-Work (PoW) and alternative methods, explaining their advantages and limitations. 5. Analyze the Bitcoin network architecture and security practices to protect users. 6. They compare Ethereum to Bitcoin, describing the key features and uses of Ether. 7. Develop smart contracts using the Solidity language, understanding their lifecycle and development process. 8. Identify and correct security risks in smart contracts through proactive measures. 9. Explain the function of Tokens and Oracles and how they enhance decentralized applications on the Ethereum Blockchain. 10. Apply knowledge through practical work and presentation of projects on modern applications of Blockchain and cryptocurrencies.
Learning outcomes	The learning outcomes of the Blockchain and Cryptocurrencies course include: • [CLO1] Critical analysis and understanding of the processes, methods, practices and techniques involved in Blockchain technology and the nature of the cryptocurrency operating process. Analyze cases where Blockchain is the most appropriate solution and compare it with other technologies for efficient problem solving. • [CLO2] Critically evaluate Blockchain and cryptocurrency technologies as a means to foster digital innovation and digital transformation in organisations, focusing on their management, security and implementation issues to enable the management and guidance of initiatives related to Blockchain and cryptocurrency technologies, enhancing digital innovation and digital transformation in organisations. • [CLO3] Discussion of the practices and challenges/benefits of new technologies based on Blockchain and cryptocurrencies in relation to traditional systems and currencies using modern tools based on this new technology. • [CLO4] Understand and apply advanced computational methods to solve complex problems and support strategic decisions. • [CLO5] Understand advanced concepts based on this new technology (such as cryptography) to deepen understanding of data security challenges, transparency and trust, and efficiency and automation.

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[CLO6] Practical understanding of Blockchain technologies and by extension cryptocurrencies in order to apply this new technology to effective business models in both the public and private sector (e.g. the banking system).
The individual objectives of the course are the following:
<table>
<tr><td>1. Knowledge</td><td>1.1 Analyse Blockchain technology and cryptocurrencies, examining both their advantages and challenges, as well as alternative distributed systems technologies.
1.2 Distinguish the key elements of a Blockchain network, comparing it to other forms of distributed and centralised systems, in order to assess when the use of Blockchain is optimal and when other technologies are more efficient.</td></tr>
<tr><td>2. Skills</td><td>2.1 Present the specific characteristics of Blockchain, analysing its benefits and limitations in relation to traditional and newer technological solutions.
2.2. Use decentralised applications (dApps), understanding how they work and evaluating their efficiency compared to digital transaction and data storage alternatives.</td></tr>
<tr><td>3. Competencies (Responsibility and autonomy)</td><td>3.1 Explain the functioning of cryptocurrencies, analysing both their technical and economic aspects and their social and regulatory implications.
3.2. Work independently on a real-time Blockchain network, applying critical thinking to select the appropriate tools and infrastructure, based on the requirements of each use case.</td></tr>
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<tr><td>Prerequisites</td><td>None</td><td>Required</td><td>None</td></tr>
<tr><td>Course content</td><td colspan="3">
<table>
<tr><td>Week</td><td>Subject</td><td>CLOs</td></tr>
<tr><td>1</td><td>Blockchain</td><td>[CLO1], [CLO2], [CLO3]</td></tr>
<tr><td>2</td><td>Bitcoin</td><td>[CLO1], [CLO2], [CLO3]</td></tr>
<tr><td>3</td><td>Bitcoin Private Key</td><td>[CLO1], [CLO3], [CLO4]</td></tr>
<tr><td>4</td><td>Transactions</td><td>[CLO3], [CLO4], [CLO5]</td></tr>
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	5	Mining	[CLO3], [CLO5], [CLO5]
	6	Bitcoin Network	[CLO1], [CLO3], [CLO5]
	7	Ethereum	[CLO4], [CLO5], [CLO6]
	8	Smart Contract Solidity	[CLO4], [CLO5], [CLO6]
	9	Smart Contract Security	[CLO4], [CLO4], [CLO6]
	10	Tokens and Oracles	[CLO4], [CLO5], [CLO6]
	11	Decentralized App (Part I)	[CLO1], [CLO2], [CLO3]
	12	Decentralized App (Part II)	[CLO1], [CLO2], [CLO3]
	13	Conclusions	[CLO1], [CLO2], [CLO3], [CLO4], [CLO5], [CLO6]

Teaching methodology

The teaching of the course "Blockchain and Cryptocurrencies" follows a combination of lectures, laboratory exercises, analytical and critical review discussions, graded interactive activities, as well as a series of formative and comprehensive assignments, to ensure a comprehensive understanding and practical application of the nature of cryptocurrencies in various aspects and Blockchain technology. It also includes group activities and discussions. The methodology includes the following elements:

- **Interactive face-to-face lectures:** Provide a theoretical basis for the course with examples and case studies to enhance student understanding.
- **Group activities/discussions:** Facilitate collaboration and exchange of ideas among students through group projects and discussions.
- **Activities and seminars:** Practical exercises and workshops to apply knowledge using programming tools and languages such as Solidity.
- **Formative and comprehensive works:** Assessment of student progress through assignments throughout the course, including the final term paper.
- **Case study and self-assessment exercises:** Real case analysis and self-assessment to improve critical thinking skills.
- **Web links and educational videos:** use online resources and videos for supplementary learning and consolidation of concepts.
- **Online quizzes:** continuous assessment of student understanding through online quizzes.
- **Final Assignment:** as part of this course, students will produce a critical research analysis on a real project or platform based on blockchain. The aim of the assignment is to connect theoretical concepts with practical applications, allowing students to explore how blockchain technology is being applied in various industries. Through independent research and analysis, students will critically evaluate the technological foundations,

	real-world applications, challenges and future potential of the chosen project. This process will help them develop their ability to objectively evaluate blockchain-based solutions, apply analytical thinking and formulate informed arguments based on credible sources. Upon completion of the project, students will have gained a deep understanding of blockchain applications, improved their research and critical thinking skills, and gained valuable insights into how blockchain technology is shaping various sectors.
Bibliography	**Required reading** • Antonopoulos, Andreas M., and David A. Harding. mastering bitcoin." O'Reilly Media, Inc.", 2023.Antonopoulos, Andreas M., and Gavin Wood. • Mastering ethereum: building smart contracts and dapps. O'reilly Media, 2018. • Bashir, Imran. mastering blockchain. packt publishing Ltd, 2017. **Extra reading** • Nakamoto, S. (2019). bitcoin: A peer-to-peer electronic cash system. manubot. • Wood, G. (2014). ethereum: A secure decentralised generalised transaction ledger. ethereum project yellow paper, 151(2014), 1-32. • Voshmgir, S. (2020). token economy: how the Web3 reinvents the internet (Vol. 2). token kitchen. • Strepparava, D., Nespoli, L., Kapassa, E., Touloupou, M., Katelaris, L., & Medici, V. (2022). deployment and analysis of a blockchain-based local energy market.Energy Reports, 8, 99-113. • Kapassa E, Themistocleous M, Christodoulou K, Iosif E. Blockchain Application in Internet of Vehicles: Challenges, Contributions and Current Limitations.Future Internet. 2021; 13(12):313. https://doi.org/10.3390/fi13120313 • Borges, C. E., Kapassa, E., Touloupou, M., Legarda Macon, J., & Casado-Mansilla, D. (2022). blockchain application in P2P energy markets: social and legal aspects.Connection Science, 34(1), 1066-1088. • Wood, G. (2014). ethereum: A secure decentralised generalised transaction ledger. ethereum project yellow paper, 151(2014), 1-32. • Andreou, A. S., Christodoulou, P., & Christodoulou, K. (2018). A decentralized application for logistics: using blockchain in real-world applications.The Cyprus Review. • Zinonos, Z., Christodoulou, P., Andreou, A., & Chatzichristofis, S. (2019, May). parkchain: an iot parking service based on blockchain. in 2019 15th International Conference on Distributed Computing in Sensor Systems (DCOSS) (pp. 687-693). iEEE.

Evaluation		**Percent (%)**	**CL01**	**CL02**	**CL03**	**CL04**	**CL05**	**CL06**
	Interactive activity 1	5%	√	√	√	√		
	Interactive activity 2	5%	√	√	√		√	√
	Interactive activity 3	5%	√					
	Interactive activity 4	5%	√	√	√	√		√
	Main coursework	20%		√	√	√	√	√
	Final exam	60%		√	√	√	√	√
	Total	**100%**						
Language	English							