

DOCTORAL (PHD) STUDIES
COURSE UNIT DESCRIPTION

Course unit title	Scientific areas	Faculty	Institute, department
Blockchain technologies	Informatics engineering (T 007)	Faculty of Mathematics and Informatics	Institute of Data Science and Digital Technologies

Study method	Number of credits	Study method	Number of credits
Lectures	1	Consultations	1
Individual works	4	Seminars	1

Summary

Annotation: This is a comprehensive blockchain technology course that helps you understand the technology and the entire ecosystem. The aim of this course is to explore the basics and principles of Blockchain and apply them to the implementation of blockchain based solutions.

Content:

1. **Introduction into cryptography** (Remigijus Paulavičius ir Ernestas Filatovas)
 - Hash functions
 - Hash pointers and data structures: *Merkle tree*
 - Digital signatures: private and public keys
2. **Blockchain fundamentals** (Remigijus Paulavičius ir Ernestas Filatovas)
 - Origin of the blockchain
 - Drawbacks of the current transactions systems
 - Ledger
 - Bitcoin and blockchain origins
 - Blockchain applications: finance, logistics, health, Internet-of-Things
3. **How blockchain technology works?** (Remigijus Paulavičius ir Ernestas Filatovas)
 - The structure of the block
 - Connecting blocks
 - Consensus algorithms: *Proof-of-Work*, *Proof-of-Stake*, *Byzantine Fault Tolerance*, *Directed Acyclic Graphs* and others.
 - Mining: nodes, complexity, algorithms, hardware.
 - Blockchain forks
 - Smart contracts
 - Security
 - Private and public blockchains
4. **The use and development of popular blockchains** (Remigijus Paulavičius ir Ernestas Filatovas)
 - The use and development of Bitcoin and Ethereum blockchains
 - AWS Blockchain templates
 - Development of the Hyperledger-type blockchain
 - Testnets
5. **Investing and analysis of cryptocurrency markets** (Saulius Masteika)
 - Cryptocurrency markets
 - ATM technological solutions
 - HFT algorithms for trading
 - Intelligent decision support systems for cryptocurrency markets

Practical tasks: Experimentally compare the most popular public and private blockchain networks, and to complete programming assignments for the creation and development of these networks. Choose the most efficient blockchain type for the given application. Apply blockchain to the given use on the testnet. To form and manage cryptographic currency investment portfolios, apply intelligent decision support systems in cryptographic currency markets, test HFT algorithms.

Main literature

1. Andrew Miller, Arvind Narayanan, Edward Felten, Joseph Bonneau, ir Steven Goldfeder. *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction* (2017).
https://d28rh4a8wq0iu5.cloudfront.net/bitcointech/readings/princeton_bitcoin_book.pdf
<https://www.coursera.org/learn/cryptocurrency>
2. Andreas Antonopoulos ir Gavin Wood. *Mastering Ethereum: Building Smart Contracts and Dapps* (2018) <https://github.com/ethereumbook/ethereumbook>
3. Andreas Antonopoulos. *Mastering Bitcoin: Programming the Open Blockchain* (2017).
<https://github.com/bitcoinbook/bitcoinbook>
4. Nakamoto, Satoshi. Bitcoin: A peer-to-peer electronic cash system (2008).
<https://bitcoin.org/bitcoin.pdf>
5. D. Hellwig, G. Karlic, and A. Huchzermeier, *Build Your Own Blockchain: A Practical Guide to Distributed Ledger Technology*. Springer International Publishing, 2020.
6. Ferguson, Niels, Bruce Schneier, ir Tadayoshi Kohno. *Cryptography engineering: design principles and practical applications* (2012).
7. AWS Blockchain Templates Resources: <https://docs.aws.amazon.com/blockchain-templates/latest/developerguide/blockchain-templates-dg.pdf>
8. Hyperledger Fabric documentation: <https://hyperledger-fabric.readthedocs.io/en/release-2.2/>
9. Online course: *Introduction to Hyperledger Blockchain Technologies*:
<https://www.edx.org/course/introduction-to-hyperledger-blockchain-technologie>
10. Online course: *Hyperledger Sawtooth for Application Developers*
<https://www.edx.org/course/hyperledger-sawtooth-for-application-developers-2>

Lecturer(s) (name, surname)	Science degree	Main publications
Remigijus Paulavičius	PhD	http://www.elaba.mb.vu.lt/dmsti/?aut=Remigijus+Paulavi%C4%8Dius
Ernestas Filatovas	PhD	http://www.elaba.mb.vu.lt/dmsti/?aut=Ernestas+Filatovas
Saulius Masteika	PhD	https://www.researchgate.net/profile/Saulius_Masteika