



COURSE DESCRIPTION

1. Program information

1.1 University	“Alexandru Ioan Cuza”, University of Iași
1.2 Faculty	Faculty of Computer Science
1.3 Department	Department of Computer Science
1.4 Study domain	Computer Science
1.5 Study cycle	Master
1.6 Study program / Qualification	Masters (Distributed systems/Software engineering/Computational optimization) / Masters in Informatics

2. Course Information

2.1 Course name	Blockchain: Foundations and Applications						
2.2 Course teacher	Emanuel Onica, Arusoai Andrei						
2.3 Seminar teacher	Emanuel Onica						
2.4 Year of study	1/2	2.5 Semester	1	2.6 Evaluation type	E	2.7 Discipline status*	OP

* OB – Obligatoriu / OP – Opțional

3. Total estimated hours (hours per semester and didactic activities)

3.1 Hours per week	4	In which: 3.2 course	2	3.3 seminar/laboratory	2
3.4 Hours in curriculum	56	In which: 3.5 course	28	3.6 seminar/laboratory	28
Time distribution					hours
Manual study, course support, bibliography, and others					14
Supplementary documentation in the library, electronic forums, and on the field					14
Seminaries/laboratories preparation, homeworks, reports, portfolios, and essays					28
Tutoring					0
Evaluation					4
Other activities					0
3.7 Total hours per individual					56
3.8 Total hours per semester					116
3.9 Credits					7.5

4. Preconditions (in necessary)

4.1 Curriculum	Object-Oriented Programming, Computer Networks, Information Security, Algorithmics
4.2 Competencies	Good programming skills

5. Conditions (if necessary)

5.1 For course operation	-
5.2 For seminary/laboratory operation	-



6. Specific skills acquired

Professional skills	C1. Create Smart Contracts in Ethereum C2. Implement decentralized applications on top of a blockchain platform
Transversal skills	CT1. The ability to design and implement a smart contract CT2. The ability to model real-life contracts as smart contracts CT3. The ability to operate with cryptocurrencies CT4. Understanding of consensus in blockchain environments

7. Course objectives

7.1 General objective	The main objective is to introduce the blockchain technology to students.
7.2 Specific objectives	After taking this course, students will be able to : <ul style="list-style-type: none">▪ Explain the specific concepts of the blockchain: blocks, transactions, hash functions, mining, consensus and consensus algorithms (Proof-of-work, Proof-of-stake, Proof-of-space-time, Proof-of-authority), wallets, peer-to-peer networks, public key cryptography▪ Design and implement a smart contract▪ Use at least one blockchain platform (Ethereum)

8. Contents

8.1	Lecture	Teaching methods	Observations (hours and bibliography)
1.	Blockchain: Introduction. Concept. Platforms: Bitcoin, Ethereum, and others. Applications	Slides, blackboard	2 hours
2.	Ethereum: accounts, smart contracts (the basics), transactions, fees, nodes and networks.	Slides, blackboard	2 hours
3.	Smart contracts: Solidity	Slides, blackboard	2 hours
4.	Smart contracts: Examples. Design Patterns. Verification.	Slides, blackboard	2 hours
5.	Decentralized applications: case studies.	Slides, blackboard	2 hours
6.	Bitcoin: the Bitcoin network. Keys. Addresses. Wallets. Transactions.	Slides, blackboard	2 hours



7.	Bitcoin: Applications. Case studies.	Slides, blackboard	2 hours
8.	Partial evaluation	Testing	2 hours
9.	Mining: Ethereum vs Bitcoin.	Slides, blackboard	2 hours
10.	Security in Ethereum	Slides, blackboard	2 hours
11.	Consensus algorithms I. General Introduction for consensus in distributed systems. Paxos. Raft.	Slides, blackboard	2 hours
12.	Consensus algorithms II. Practical Byzantine Fault Tolerance. Proof of work. Proof of stake. Proof of space-time. Proof of authority.	Slides, blackboard	2 hours
13.	Ethereum – advanced notions. The Whisper protocol. Swarm.	Slides, blackboard	2 hours
14.	HyperLedger Fabric. Other platforms. Cryptocurrency.	Slides, blackboard	2 hours

Bibliography

- [1] Blockchain Applications: A Hands-On Approach (A. Bahga, V. Madiseti) – VPT Publishing House, 2017
[2] Mastering Bitcoin: Programming the Open Blockchain (A. M. Antonopoulos) – O'Reilly Media, 2017
[3] Practical Byzantine Fault Tolerance (M. Castro, B. Liskov) - Proceedings of the Third Symposium on Operating Systems Design and Implementation, USENIX OSDI 1999
[4] Hyperledger Fabric: A Distributed Operating System for Permissioned Blockchains (E. Androulaki et al.) – Proceedings of the ACM EuroSys 2018 Conference

8.2	Seminar / Laboratory	Teaching methods	Observations (hours and bibliography)
1.	Ethereum clients and wallets. Setup: installing tools for Ethereum.	Introductory discussions.	2 hours
2.	Ethereum tools for development. Solidity: create and build your first smart contract.	Introductory discussions.	2 hours
3.	Solidity: smart contracts development	Exercises proposal and discussions.	2 hours
4.	Solidity: smart contracts design patterns I	Exercises proposal and discussions.	2 hours
5.	Solidity: smart contracts design patterns II	Exercises proposal and discussions.	2 hours
6.	Smart contracts use cases. Homework evaluation.	Direct discussions.	2 hours
7.	Decentralized applications – introduction and examples	Introductory discussions.	2 hours
8.	Description of semestrial project: a decentralized application on Ethereum or other platforms	Discussions over the project proposal.	2 hours



9.	Decentralized applications development.	Exercises proposal and discussions.	2 hours
10.	Decentralized applications. Use cases. Presentation of research articles in the blockchain technical field.	Free discussions.	2 hours
11.	Security in smart contracts and DApps. Presentation of research articles in the blockchain technical field.	Exercises proposal and discussions.	2 hours
12.	Project work. Presentation of research articles in the blockchain technical field.	Exercises proposal and discussions.	2 hours
13.	Project work. Presentation of research articles in the blockchain technical field.	Exercises proposal and discussions.	2 hours
14.	Semestrial project: final presentation.	Evaluation. Direct discussions.	2 hours

Bibliography
[1] Blockchain Applications: A Hands-On Approach (A. Bahga, V. Madiseti) – VPT Publishing House, 2017
[2] Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain (R. Modi) – Packt Publishing, 2018

9. Course content synchronization with the expectations of the community representatives, professional associations and employers from the program domain

This discipline aims to develop the ability to understand and use a blockchain platform. Blockchain platforms and in particular decentralized applications received lately increased attention from the industry. Multiple distributed frameworks, especially in the financial technology area currently try to adopt the blockchain model. Therefore, the technical topics discussed by the course are of high interest especially in the current context of enterprise software industry environment.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 The weight of each evaluation form (%)
10.4 Course	<ul style="list-style-type: none">- understanding of the blockchain architecture concepts, both in general and in particular for the Ethereum and Bitcoin platforms- understanding of development paradigms- capacity to identify and address various scalability, consensus, and security issues in blockchain- quality of stating the answers	Written tests	50%



10.5 Laboratory	<ul style="list-style-type: none">- the capacity to program smart contracts and applications for the Ethereum blockchain platform- reading and summarizing the relevant information in various publications of the scientific field- the quality of the project development	Research paper presentations, homeworks and semestrial project	50%
10.6 Minimal performance standards			
The following criteria must be met: <ul style="list-style-type: none">- 50% from the overall maximum points, with no less than 50% on each of the two grade components (course and laboratory)			
For the theoretical side the fulfillment of the minimal conditions implies the understanding of the basic theoretical notions regarding the blockchain architecture.			
For the practical side the fulfillment of the minimal conditions implies implementing a decentralized application project proposal that runs over blockchain.			

Data completării,
30.09.2019

Titular de curs,
Emanuel Onica, Andrei Arusoaie

Titular de seminar,
Emanuel Onica

Data avizării în departament,

Director de departament,