COURSE DESCRIPTION

1. Program information

1.1 University	**“Alexandru Ioan Cuza”, University of Iaşi**
1.2 Facultty	**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, Arusoaie 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 – Opţional*

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**
Suplementary 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 : ▪ 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.	Design patterns in Solidity.	Slides, blackboard	2 hours
6.	Decentralized applications: case studies.	Slides, blackboard	2 hours

7.	Bitcoin: the Bitcoin network. Keys. Addresses. Wallets. Transactions.	Slides, blackboard	2 hours
8.	Bitcoin: advanced aspects. Blocks. Mining.	Slides, blackboard	2 hours
9.	Bitcoin: advanced aspects. Bitcoin-Ethereum interactions. Smart contracts in Bitcoin.	Slides, blackboard	2 hours
10.	Security in Ethereum.	Slides, blackboard	2 hours
11	Partial evaluation.	Testing	2 hours
12.	Consensus algorithms I. General Introduction for consensus in distributed systems. Paxos. Raft.	Slides, blackboard	2 hours
13.	Consensus algorithms II. Practical Byzantine Fault Tolerance. Proof of work. Proof of stake. Proof of space-time. Proof of authority.	Slides, blackboard	2 hours
14.	Ethereum – advanced notions: The Whisper protocol, Swarm. Other blockchain platforms: Hyperledger Fabric. Cryptocurrencies.	Slides, blackboard	2 hours

Bibliography

[1] Blockchain Applications: A Hands-On Approach (A. Bahga, V. Madisetti) – 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 – inheritance, interfaces, testing.	Exercises proposal and discussions.	2 hours
5.	Solidity: smart contracts - design patterns.	Exercises proposal and discussions.	2 hours
6.	Homework evaluation.	Evaluation. Direct discussions.	2 hours
7.	Decentralized applications – introduction and examples	Introductory discussions.	2 hours
8.	Description of semestrial project.	Discussions over the project proposal.	2 hours

9.	Tokens. Presentation of research articles in the blockchain technical field.	Exercises proposal and discussions. Evaluation.	2 hours
10.	Security in smart contracts and DApps. Quorum example. Presentation of research articles in the blockchain technical field.	Free discussions. Evaluation.	2 hours
11.	Confidentiality in contracts. Quorum example. Presentation of research articles in the blockchain technical field.	Free discussions. Evaluation.	2 hours
12.	Ethereum in desktop or enterprise applications. Web3j example. Presentation of research articles in the blockchain technical field.	Free discussions. Evaluation.	2 hours
13.	Project work. Presentation of research articles in the blockchain technical field.	Free discussions. Evaluation.	2 hours
14.	Semestrial project: final presentation.	Evaluation. Direct discussions.	2 hours

Bibliography

[1] Blockchain Applications: A Hands-On Approach (A. Bahga, V. Madisetti) – 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 weigth of each evaluation form (%)**
10.4 Course	- 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 (Note: in the context of online teaching, the examination will be conducted using adequate means fit for the online context)	30%

10.5 Laboratory	- 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 (Note: in the context of online teaching, the presentations will be conducted online using specific means)	70%
10.6 Minimal performance standards			
The minimal passing grade criteria is fulfilling the minimal conditions described below, which corresponds to acummulating a minimum of 50% of the total aggregated maximum points, independent of the grading for each of the two 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, 30.09.2020	Titular de curs, Emanuel Onica, Andrei Arusoaie	Titular de seminar, Emanuel Onica

Data avizării în departament, Director de departament,