UNIVERSITY of NICOSIA

Course Syllabus

Course Code	Course Title	ECTS Credits
META-522	Smart Contracts Programming for Metaverse Applications	10
Prerequisites	**Department**	**Semester**
None	Digital Innovation	Fall/Spring
Type of Course	**Field**	**Language of Instruction**
Elective	Metaverse	English
Level of Course	**Lecturer**	**Year of Study**
2nd Cycle	Dr. Klitos Christodoulou	1st
Mode of Delivery	**Work Placement**	**Corequisites**
Face to face	N/A	N/A

Course Objectives:

The main objectives of the course are to:

1. Explain Metaverse decentralization and how it relates to blockchain technology.
2. Provide students with an in depth understanding of smart contracts and how they enable decentralization and automation in the Metaverse.
3. Equip students with the skills in designing and implementing smart contracts for Metaverse applications.

Learning Outcomes:

After completion of the course students are expected to be able to:

1. Understand Metaverse decentralization and the Blockchain
2. Apply knowledge of Ethereum-based smart contracts
3. Design smart contracts for the Metaverse applications
4. Develop smart contracts for the Metaverse applications

Course Content:

Session 1. Introduction to Metaverse decentralisation

- Metaverse decentralization and the Blockchain
- Blockchain Architectural Overview
- The Web of Trust
- Ethereum's main components
- Ethereum's sub-protocols

- Smart Contracts and Decentralized Applications (dApps)
- Web apps vs. dApps

Session 2. Metaverse and smart contracts

- An overview to the history of smart contracts
- Smart contracts enabling decentralization and automation in the Metaverse
- Examples of smart contracts in Metaverse applications
- Smart contract lifecycle
- Ethereum's smart contract languages
- Interfacing with Ethereum Networks (overview of Ethereum Networks, Clients, Wallets, Transactions etc.)
- The Solidity Programming Language
- Development Environments

Session 3. Ethereum based smart contracts

- Overview of Ethereum's tech stack, architecture
- The Ethereum reward scheme, Mist, EVM, Swarm, Whisper, Eth, Gas
- A simple Solidity Contract (Contract Walk-through)
- The Solidity compiler
- Ethereum Contract ABI
- Deployment with the Web3.js or Web3J library

Session 4. Virtual Machines and Beyond

- History of Virtual Machines
- State replication, consensus, and the Ethereum Architecture
- Introduction to the Ethereum Virtual Machine and EVM Byte Code interpretation
- Incentivisation structures, rewards schemes, and gas pricing

Session 5. Metaverse dApp development pipeline

- Introduction to development with Solidity
- Development environments (Truffle)
- Intro to Solidity
- Smart contract layout
- The structure of.*sol* source file

Session 6. Deep-dive into Solidity

- Understanding the different compiler versions and pragmas
- Authoring smart contracts
- Contract definitions
- Basic data types
- Local and State Variables

Session 7. Global variables and functions

- Predefined Global Variables
- Structs and Enums
- Mapping and Arrays
- Build-in Functions (e.g., addmod, keccak256)

- User Functions

Session 8. Expressions and control structures
- Valid expressions of the language
- Exception Handling (e.g., assert, require, revert, throw)
- Events and Logging
- Conditional logic
- Implementation of loops

Session 9. Object oriented constructs
- Contract constructor and selfdestruct
- Function Modifiers and Fallback functions
- Calling other contracts
- Inheritance and Multiple Inheritance
- Declaring Abstract Classes and Interfaces
- Implementation of Abstract interfaces
- Function Overloading

Session 10. Experimenting with front-end libraries
- Intro to front-end web interfaces
- Decentralized Data Storage
- The Ethereum Name Services (ENS)

Session 11. Unit testing and debugging contracts
- Estimating Gas Costs
- Basics of using Truffle for testing
- Troubleshooting and Debugging
- Common design patterns
- Smart Contract Security – overview of attacks on Ethereum smart contracts

Session 12. Smart contract programming for Metaverse application project
- Working in teams to design smart contacts for a Metaverse application
- Implement smart contacts for a Metaverse application prototype
- Presentation and analysis of the project
- Exploring trends in smart contracts programming for the Metaverse

Learning Activities and Teaching Methods:

- Faculty Lectures
- Guest-Lectures Seminars
- Directed and Background Reading
- Case Study Analysis
- Academic Paper Discussion
- Simulations
- Student-led Presentations
- In-Class Exercises

Assessment Methods:

- Interactive activities and classroom participation
- Project
- Final exams

Assessment Methods in alignment with Intended Learning Outcomes:

		Intended Learning Outcomes to be assessed			
Assessment Method	**Weighting**	LO1	LO2	LO3	LO4
Interactive activities	12%	✓	✓	✓	✓
Project	28%	✓	✓	✓	✓
Exams	60%	✓	✓	✓	✓

Student Study Effort Expected:

Student Study Effort Expected	Hours
Lectures	12h
Project	80h
Interactive activities and participation	20h
Reading and research	135h
Exam	3h
Total	250h

Required Textbooks / Readings:

Title	Author(s)	Publisher	Year	ISBN
Mastering Ethereum: building smart contracts and dapps	Antonopoulos, Andreas M., and Gavin Wood.	O'Reilly Media	2018	978-1491971949

Recommended Textbooks / Readings:

- Atzei, N., Bartoletti, M., & Cimoli, T. (2017). A survey of attacks on ethereum smart contracts (sok). In International Conference on Principles of Security and Trust (pp. 164-186). Springer.
- Christodoulou, K., Katelaris, L., Themistocleous, M., Christoudoulou, P., & Iosif, E. (2022). NFTs and the Metaverse Revolution: Research Perspectives and Open Challenges. In M. Lacity & H. Treiblmaier (Eds.), Blockchains and the Token Economy: Theory and Practice (pp. 139-178). Palgrave Macmillan.
- ConsenSys. (n.d.). A guide to available tools and platforms for developing on Ethereum. GitHub. https://github.com/ConsenSys/ethereum-developer-tools-list

- ConsenSys. (n.d.). Decentralized Storage: The Backbone of the Third Web. ConsenSys. https://media.consensys.net/decentralized-storage-the-backbone-of-the-third-web-d4bc54e79700
- ConsenSys. (n.d.). Ethereum Ecosystem Resources. GitHub. https://github.com/ConsenSys/ethereum-developer-tools-list/blob/master/EcosystemResources.md
- Mohan, C. (2018). Blockchains and databases: A new era in distributed computing. In 2018 IEEE 34th International Conference on Data Engineering (ICDE) (pp. 1739-1740). IEEE.
- Seijas, P. L., Thompson, S. J., & McAdams, D. (2016). Scripting smart contracts for distributed ledger technology. IACR Cryptology ePrint Archive, 2016, 1156.
- Trón, V., Fischer, A., Nagy, D. A., Felföldi, Z., & Johnson, N. (2016). Swap, Swear, and Swindle: Incentive System for Swarm.
- Wattenhofer, R. (2016). The science of the blockchain. CreateSpace Independent Publishing Platform.
- Wood, G. (2014). Ethereum: A secure decentralised generalised transaction ledger. Ethereum project yellow paper, 151(2014), 1-32. http://gavwood.com/paper.pdf
- Awesome Solidity. (n.d.). GitHub. https://github.com/bkrem/awesome-solidity
- https://medium.com/nerd-for-tech/how-to-build-a-smart-contract-for-metaverse-3516bcc3d052
- Moralis, 2022, How to build a metaverse game smart contract https://moralis.io/metaverse-smart-contract-how-to-build-a-metaverse-game-smart-contract/
- Metaverse and Smart contracts, 2022, https://www.oodlestechnologies.com/blogs/metaverse-and-smart-contracts:-a-brief-review/
- Smart Contracts in Metaverse: A Closer Look, 2022, https://www.codeglo.com/blog/smart-contracts-in-metaverse-a-closer-look/