

CSE 410-510

Bina Ramamurthy

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CSE410/510 Special Topics: Decentralized Finance (DeFi) Systems

This course is intended for students interested in learning about blockchain, cryptocurrency, and decentralized finance systems. The course will cover the essentials of blockchain and cryptocurrency and explore the area of Decentralized Finance (DeFi) systems in detail. The course content is divided into three parts: (i) blockchain essentials, (ii) digital assets, and (iii) DEX protocols and platforms, including applications of web3 and DeFi to modernize business systems. The topics covered in the first part of the course include decentralized identity, wallet technology, peer-to-peer transactions, blocks, chain of blocks, smart contracts, web3, and decentralized applications (DApp). These concepts will be illustrated using the Ethereum blockchain. The second part of the course covers digital assets and includes a discussion of cryptocurrencies, tokens and tokenization, fungible, non-fungible, and multi-token, and their applications. The concepts will be reinforced using Ethereum's ERC tokens and real-world assets (RWA) tokens. The course's third part deals with decentralized exchange (DEX) protocols and platforms, newer models for liquidity, market and market making, and perpetual derivatives. The course will also discuss approaches for introducing web3 and DeFi concepts into existing businesses and systems. Students will work on hands-on projects on Ethereum testnets and simulated environments to reinforce the concepts discussed. Upon completion of the course, a student will be able to analyze a problem and develop and implement an end-to-end DeFi system to solve a real-world problem.

Course Outcomes

Upon completion of the course, a student will be able to explore blockchain and cryptocurrency applications with their wallets, understand security and scalability issues, conceptualize decentralized systems, and be educated about the new roles they can play in a decentralized systems and applications. They will be able to design and implement DeFi systems to modernize existing systems to include DeFi aspects. The course will provide students sufficient background to solve problems using blockchain technology, its safe and secure use, and best practices. It will help students launch a career as designers and thought leaders in building practical and secure blockchain systems.

Course Prerequisite

CSE250 Data Structures, equivalent, or permission of the instructor. You should have a good foundation in problem-solving, data structures and algorithms and design representation. Prior knowledge of blockchain is not required.

Course Information

- Website for general information: <http://www.cse.buffalo.edu/~bina/cse406>
- Course material will be posted on Learning Management System (LMS)

- Instructor: Bina Ramamurthy (bina@buffalo.edu)
- Lecture Time: Wed 5:00PM - 7.50 PM
- Lecture Location: 111 Talbert
- Office Hours: Wed 2.00 - 4.00 PM on zoom Zoom Meeting <https://buffalo.zoom.us/j/99319239267?pwd=WAKMHvbbR2kH9nNCc6xvAqfk5mkzqS.1> Meeting ID: 993 1923 9267 Passcode: 645692

Text book

B. Ramamurthy. Blockchain, Cryptocurrency and Decentralized Finance: Concepts and Applications. (Not yet published, but your teacher will provide references) The instructor will provide many reference material throughout the course to support the practical explorations.

Grading Policy

Grading Distribution Final letter grades will be based on the (combined) overall percentage of all the items listed below. A (95 -), A- (90 - 94), B+ (85 - 89), B (80 - 84), B- (75 - 79), C+ (70 - 74), C (64 - 69), C- (55 - 64), D (50 - 54), F (less than 50). This policy is subject to change. If needed, the individual components and the overall grades will be appropriately curved.

Grade components

Component	Points
Class activity on blockchain	100
Quizzes	100
Exam 1 (1)	100
Practical DeFi Use Case: Project and Report	100

Syllabus

Lecture	Concepts/topics	Hands-on Exploration
1	Foundations in algorithms, data structures and algebra. Blockchain Tx, block, chain of blocks; distributed immutable ledger; network of nodes; consensus algorithm; decentralized identity (DeID); Examples; Ethereum blockchain	Students self-generate decentralized identifier for themselves using a tool
2	Digital Wallets; Features of a wallet; Private-public key: digital signing; P2P transactions on testnet;	Install a cryptowallet such as MetaMask; Obtain test ethers from testnet faucet and transact
3	Smart contracts: structure and functions; Execution in a Ethereum Virtual Machine (EVM) sandbox for consistency among nodes; Solidity language; Remix Environment for simulating smart contract deployment and execution.	Access Remix web environment and explore its features
4	Web3 and decentralized application (Dapp) stack; web3 = web2 + blockchain trust; special features of a smart contract: How smart is a smart contract?	Interact with a Dapp deployed on a testnet and understand the role of wallet and smart contracts

Lecture	Concepts/topics	Hands-on Exploration
5	Introduction to cryptocurrency; Bitcoin, Ethereum, and Zcash: Innovation in their technologies; Explore consensus algorithms: Proof of work (POW) and proof of stake (POS)	Explore scan of Txns on the networks; Identify significant events such as Bitcoin halving; Ethereum Proof-of-Work (POW) to Proof-of-stake (POS)
6	Tokens and Tokenization; Fungible token (FT); Non-fungible token (NFT); Multi-asset token.	Design and deploy FT and NFT
7	Digital assets: Tokenizing real-world assets (RWA); Ethereum standards process;	Analysis of real-world use cases
8	Stablecoin: Fungible cash for global trade and commerce;	Explore stablecoins in use
9	Decentralized autonomous organization (DAO) and governance;	Explore DAO, voting and governance
10	Non-functional features: Scalability, Security and privacy; Layer 2 scalability solutions.	Add Layer 2 to MetaMask wallet and transact
11	Decentralized finance: markets, liquidity, liquidity pools; Centralized crypto exchanges;	Explore buying, swapping and bridging test crypto
12	DeFi: Protocols and platforms: DEXs; Use case: web3 supply chain.	Explore Uniswap platform
13, 14	Demo of your use case for crypto and DeFi	Student demo/presentation

Exams and quizzes

There will be a midterm that will be administered and graded before the resignation date. This exam will cover all lecture and reading assignments before the exam and concepts from the lab assignments. The exam is closed books, closed notes, and closed neighbors. We do not give makeup exams for any reason. If you miss the exam, you will receive a zero for that portion of the grade. Quizzes will be pop quizzes and may be unannounced. No makeup quizzes will be given.

Attendance Policy

You are responsible for the contents of all lectures. Of course, there is no excuse for missing due dates or exam days. Attendance will be taken and will determine the attendance grade component to compute your final grade. During lectures, we will be covering material from the textbook. We will also work out several of the problems from the text. Lectures will feature exploring several real-world and practical problems not covered in the book. Lecture dynamics will depend very much on students' participation, and students are strongly encouraged to ask questions related to the material covered in the class. You will be given a reading assignment for the next class at the end of each lecture.

Office Hour Policy

If you can't meet during the designated office hours, you will have to communicate via Email. Office hours are intended to resolve questions about the material that could not be answered in lectures or recitation. Come to office hours prepared! Office hours are NOT for repeating missed lecture material or having the instructor or TA solve an assigned problem for you. Office hours are designed to review complex class concepts and

work required for the course. This time is your time to communicate with me about the course, project, exams, quizzes, etc. Use the opportunity to the fullest.

Grading Policy

All assignments will be graded and returned promptly. When an assignment is returned, you will have one week to contest any portion of the grade. The judgment of the instructor will be final in all such cases. When contesting a grade, you must demonstrate how your particular solution is correct. Also, when contesting a grade, the instructor reserves the right to reevaluate the entire lab or exam, not just the portion in dispute.

Incomplete Policy

We only grant incompletes in this course under the direst of circumstances. An incomplete is warranted if the student cannot complete the course satisfactorily, such as a traumatic event that has interfered with their ability to finish within the semester's timeframe. Incompletes are not designed as a stalling tactic to defer a poor performance in a class.

Academic Integrity Policy

UB's definition of Academic Integrity in part is, "Students are responsible for the honest completion and representation of their work." It is required as part of this course that you read and understand the departmental academic integrity policy located at the following URL: <https://www.buffalo.edu/academic-integrity/policies.html> There is a fine line between conversations about concepts and academic dishonesty. You are allowed to converse about general ideas, but in no way are you allowed to share code or have one person do the work for others. You must abide by the UB and Departmental Academic Integrity policy at all times. NOTE: Remember that the academic integrity policy also covers items taken from the Internet! If you are unsure if a particular action violates the academic integrity policy, assume that it does until you receive clarification from the instructor.

Piazza

Here is the piazza link; <https://piazza.com/buffalo/fall2024/cse406506>, please enroll. Course assignments, slides, grade reporting, and general hints and tips will be posted on the ublearns blackboard LMS system. There is a licensed version of piazza for your class discussions. Please enroll in it and make the best use of it. Piazza is only for any public discussion related to the course, so be civil. Also, do not post any code publicly on Piazza. Piazza cannot solve any individual grading question. In this case, you should contact your TA or the instructor for grading questions.

Students with Accessibility Issues

If you have special needs due to a disability, you must be registered with the Office of Student Accessibility. If you are registered with them, please let your instructors know about this so that they can make special arrangements for you.

Piracy and illegal use of course material

All materials I prepared and/or assigned for this course are for the students' educational benefit. Other than for permitted collaborative work, students may not photograph, record, reproduce, transmit, distribute, upload, sell or exchange course materials without my prior written permission. "Course materials" include, but

are not limited to, all instructor-prepared and assigned materials, such as lectures; lecture notes; discussion prompts; study aids; tests and assignments; and presentation materials; and course packets or handouts. Public distribution of such materials may also constitute copyright infringement in violation of federal or state law. Violation of this policy may additionally subject a student to a finding of “academic dishonesty” under the Academic Integrity Policy and/or disciplinary charges under the Student Code of Conduct.

Violations

Students who violate this policy will be required to complete an educational sanction about the value of intellectual property. More serious and/or repeat violations of this policy may be treated as acts of “academic dishonesty” under the Academic Integrity Policy at (<https://www.buffalo.edu/academic-integrity/policies.html>) or subject a student to disciplinary charges under the Student Code of Conduct.