**Introduction to Blockchain and Cryptocurrencies**

**Fall 2021 Syllabus**

**INSTRUCTORS**

**Professor Gur Huberman**

**E-mail:** [**gh16@gsb.columbia.edu**](mailto:gh16@gsb.columbia.edu)

**Professor Omid Malekan**

**E-mail:** [**om44@columbia.edu**](mailto:om44@columbia.edu)

**Office Hours: By Appointment**

**Course Description**

This course will introduce the fundamental building blocks of blockchain technology as well as its application in cryptocurrencies, stablecoins, decentralized finance and non-fungible tokens (NFTs). It will begin by covering the fundamentals of money, banking, and payment systems, as well as relevant areas of computer science such as cryptography and distributed systems. Special attention will be paid to the different building blocks of the Bitcoin network and how they work together, and the unique attributes of the Ethereum platform.

The course will then shift towards specific applications beyond cryptocurrency, including stablecoins, central bank digital currencies, decentralized finance and non-fungible tokens. Layer 2 solutions, newer blockchain platforms, different consensus mechanisms and private networks will also be covered.

The course will focus as much on how the technology works as on what it might change. There will be live demos and guest speakers from the industry throughout.

**Course Co-Requisites**

Capital Markets and Investments (B8306/B7306)

**Grading**

There will be reading and homework assignments throughout the course, some of which will be completed in groups. The midterm will be an in-class individual exam on fundamental concepts. For the final, each group will propose their own blockchain-enabled solution or a new business to be built atop an existing one. The final project grade will be based on comprehension of the problem solved, followed by analysis of the economics of the solution, governance and the go-to-market strategy.

Course grades will be determined as follows: 30% final project, 30% assignments, 20% midterm and 20% participation.

**TENTATIVE OUTLINE:**

**Class 1 – Money, banking & payment systems, Challenges of digitization**

This session will provide theories on the origins of money and its history. It will cover the generally accepted functions of money as well as its characteristics. It will discuss the basics of banking and the design of payment systems. It will end with a review of the challenges of digitization that Bitcoin was invented to solve.

**Class 2 – Consensus, hash functions & symmetric cryptography**

The primary focus of this class will be how distributed systems can reach consensus, and the technical concepts of hashing and basic cryptography. Subsequently we’ll discuss how blockchain was invented prior to Bitcoin, how it can be used to authenticate and time stamp digital documents, and why doing so is a proper foundation for a decentralized payment network. We’ll conclude with a review of public key cryptography.

**Class 3 – Bitcoin**

All of the technical concepts learned so far will be used to understand the invention and working of Bitcoin. The focus will be on the use of economic incentives, mining, transaction fees and algorithmic inflation.

**Class 4 – Ethereum, Smart contracts and tokens**

This session will cover conditional transactions as enabled by the second most prominent blockchain platform, tokens, and the notion of trustless computing. It will provide a history of the Ethereum ecosystem, discuss its challenges, and review several prominent applications built on top of it.

**Class 5 – The user’s perspective; Vulnerabilities**

This session will cover the different aspects of owning cryptocurrency and interacting with a blockchain, including buying and selling, wallets, supportive infrastructure such as exchanges and custodians, and the dangers of a digital bearer asset. We will also discuss the risks and tradeoffs of decentralized networks, including possible attack vectors and 51% attacks, with a review of several successful breaches. Soft and hard forks will be covered.

**Class 6 – Midterm**

**Class 7– Stablecoins & Central Bank Digital Currencies**

This class will cover blockchain tech as applied to fiat currency, the difference between token and ledger money, similarities and differences with existing payment solutions, and the possible disruption of the payments industry. It will then shift to the emerging field of CBDCs, the different models being considered, the Digital Yuan and the proposed Digital Euro, as well as the impact on commercial banking.

**Class 8 – Decentralized finance; Tokenization of capital markets**

This session will cover decentralized applications for credit creation, money markets and synthetic assets on the Ethereum blockchain, with a deep dive into several existing projects. It will cover the emergence of new financial primitives, yield farming and the power of composability. It will end with the potential impact on existing capital markets.

**Class 9 – Non-Fungible tokens, social tokens and online communities**

This session will focus on the emergence of NFTs and the potential impact on the worlds of content creation, digital art, collectibles and pop culture. It will review prominent NFT projects, social tokens, token-enabled curation models and different applications for token-gating content.

**Class 10 – Alternative consensus mechanisms, newer Layer 1s and emerging Layer 2s**

This session will focus primarily on different variations of Proof-of-Stake. It will review the differences between alternative layer 1 protocols such as Cosmos, Polkadot and Solana and end with a lecture on different Layer 2 approaches such as the Lightening Network and rollups.

**Class 11 – Tokenomics, real-world applications and private networks**

This class will review the basics of token enabled protocols and decentralized applications. It will review decentralized versions of real-world applications outside of financial services such as cloud storage and telecommunication. It will end with a lecture on private & permissioned networks.

**Class 12 – Student presentations**