

Course Content

Course Code	Core Courses (Blockchain Fundamentals)
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SC6103	Distributed Systems
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SC6106	Blockchain Development Fundamentals – Part 1
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SC6108	Blockchain and Smart Contract Security
SC6109	Blockchain Privacy and Scalability
Course Code	Elective Courses (Blockchain Development)
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SC6113	Development of Decentralized Applications
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SC6122	Emerging Topics in FinTech
SC6123	Blockchain Business Applications
SC6124	Ethics and Laws in Blockchain
SC6125	Blockchain in Finance
Course Code	Project
SC6131	Blockchain Innovation Project

*Note: Not all courses listed in the curriculum will be offered in a trimester. Courses offered are subject to the availability of instructors and resources.

Course Details – Core (Blockchain Fundamentals)

SC6101 & SC6102 - Introduction to Blockchain Technology

(Part 1 and 2)

This course adopts an interdisciplinary approach to provide an overview of cryptocurrencies and blockchain technology from a technical, operational, business and legal perspective. You will build up conceptual foundations that will enable you to understand the underlying technologies of blockchain and its disruptive implications across industries. Upon the successful completion of the course, you should be able to:

1. Describe the “why, how and what” of blockchain technology, with a focus on Bitcoin, Ethereum, and Algorand;
2. Discuss current and potential real-world applications powered by blockchains;
3. Understand the principles and challenges of blockchain governance, from a Singapore and global perspective.

SC6103 - Distributed Systems

This course aims to develop students’ understanding of the basic architectures, algorithms and design principles of distributed computing systems, and how they meet the demands of contemporary distributed applications, such as blockchain. This course provides an introductory but broad perspective of distributed systems, and is relevant for anyone pursuing a career in the IT/ICT industry – including those in product design and development, network/system administration, as well as, given the proliferation of IT in all walks of our lives, in executive roles across industries and government.

This course introduces distributed systems at an intermediate level. Upon the successful completion of this course, students shall be able to:

1. Explain the fundamental concepts and main features of distributed systems.
2. Describe the architectures of distributed systems.
3. Describe the functions of software components and common services to support distributed applications.
4. Analyse and apply the basic distributed algorithms.
5. Apply key design principles to an implementation of distributed system.

SC6104 - Introduction to Cryptography

This course aims to develop students’ ability to understand how basic cryptographic algorithms work and identify the problems associated with the application of cryptography in blockchain systems, and explain the pros and cons of various cryptographic mechanisms. This course provides an introduction to basic cryptographic algorithms, along with the

underlying mathematical foundations guiding the design of algorithms, and explores the usage of these primitives in blockchain applications.

This course provides an understanding of cryptography and network security at an intermediate level. Upon the successful completion of this course, students shall be able to:

1. Apply the theoretical (mathematical) tools that form the basis of cryptographic algorithms;
2. Explain and analyze the design of cryptographic algorithms;
3. Identify the typical problems associated with the application of cryptography in blockchain systems;
4. Explain the security issues in a blockchain environment

SC6105 - Software Engineering

This course aims to equip students with foundation knowledge on issues and techniques required for the design and implementation of quality software. Students will have the necessary knowledge and skills to develop blockchain-based software applications.

Upon completion of the course, students will be able to understand the roles and purposes of various activities in software engineering process. Specifically, they will be able to

1. Participate in all stages of the Software Development Life Cycle for a medium-size software project to deliver the required work products.
2. Elicit and specify requirements clearly and correctly.
3. Use good software design concepts and considerations.
4. Design and carry out test activities to verify that requirements have been met.
5. Perform simple project management of a medium-size software project.

SC6106 & SC6107 - Blockchain Development Fundamentals

(Part 1 and 2)

This course explores, in depth, imperative aspects of the technologies underpinning today's blockchain systems. From cryptographic primitives, distributed consensus algorithms, smart contract implementation details, attacks and mitigations to advanced frontier topics like scalability solutions, this course will equip students with the necessary knowledge and skills for advanced blockchain development. Upon the successful completion of the course, students should:

1. Have a solid technological foundation of Blockchain technologies;
2. Understand how Bitcoin and Ethereum works, their respective bottlenecks and proposed solutions;
3. Scientifically evaluate the security and theoretical limitations of most blockchain systems.

SC6108 - Blockchain and Smart Contract Security

This course focuses on the security aspects of the blockchain technology. The security issues of blockchain range from the network layer, blockchain consensus, to the application layer, including smart contract and decentralized application security. This course will equip students with the knowledge to understand and analyse blockchain-related security vulnerabilities and attacks, and the ability to propose reasonable defences to these issues.

Specific topics include:

1. P2P network layer attacks such as BGP hijacking, eclipse attacks
2. Attacks on blockchain consensus protocols such as 51% attack, collusion, censorship, selfish mining, block withholding, front running and transaction reordering
3. Smart contract-related application layer attacks such as re-entrancy attacks, integer overflow/underflow, race condition, exception disorder, etc.

SC6109 - Blockchain Privacy and Scalability

This course focuses on the recent advances in blockchain privacy, scalability, and interoperability. Privacy and scalability are two important practical issues to consider for the next-generation blockchain platforms. Students will be introduced to the state-of-the-art blockchain privacy, scalability, and interoperability solutions, and able to evaluate and reason about their applicability in different application scenarios.

Specific topics include:

1. Blockchain privacy: anonymity and linkability, CoinJoin, CoinShuffle, Monero, ZeroCash protocol
2. Blockchain Scalability: sharding approaches, Layer 2 technologies such as channels, Plasma, ZK Rollup, and data availability proof
3. Blockchain interoperability: pooled security, inter-blockchain communication, sidechains, Plasma bridge, etc.

Course Details – Elective (Blockchain Development)

SC6111 - Web Programming Basics

This course is an introduction to programming for the World Wide Web. Student will learn about the relationship between clients and servers, briefly how the Internet works, and how Web pages are constructed using several technologies:

- HyperText Markup Language (HTML) for authoring web pages
- Cascading Style Sheets (CSS) for applying stylistic information to web pages
- JavaScript (JS) for creating interactive web pages

- Asynchronous JavaScript and XML (Ajax) for enhanced web interaction and applications
- PHP web services for handling and responding to web services requests
- Structured Query Language (SQL) for interacting with databases

In the process of learning these technologies, student will also:

- Practice the skill of reading detailed specifications and writing readable, well-documented, and structured code
- Learn how to appropriately search for and evaluate solutions
- Have an opportunity to develop an individual portfolio to show prospective employers

SC6112 - Blockchain Solutions and Smart Contracts

This course introduces students to the technologies surrounding blockchains and distributed ledgers, and their application to creating transformational business solutions. Students will examine the rapidly evolving landscape of blockchain platforms, decentralized applications and smart contracts. Students will gain practical experience with current full-stack blockchain development technologies, including smart contracts, user interfaces, data storage and integration with business processes. Students will critically analyse the application of blockchain technology to a specific industry or context and design an appropriate blockchain-enabled solution to transform that industry. Upon successful completion of this course, students will be able to:

1. Characterise the key concepts of blockchain technologies in the context of their transformative potential in business.
2. Research and critically assess the application of blockchain technologies to various business contexts and industries.
3. Design and construct applications that use smart contract programming.
4. Analyse real-world problems and design blockchain-enabled solutions.
5. Critique and recommend appropriate blockchain platforms and technologies to create blockchain-enabled business solutions.

SC6113 - Development of Decentralized Applications

This course aims to provide students with hands-on experience in the design and implementation of a decentralized application. The course focuses on Ethereum and Algorand, and their development environments. Other tools and libraries in decentralized application development from testing to frontend RPC connection will be introduced. Token standards, best design paradigms and security issues will also be covered. Upon the successful completion of the course, students should have:

1. Experienced the complete lifecycle of decentralized application development;
2. Learnt good paradigms in blockchain application design;
3. Delivered an Ethereum/Algorand decentralized application for a specific use case.

SC6114 - Software Project Management

This course aims to introduce advanced software engineering management topics including Quality Management, Project Management, Configuration Management, and Maintenance, according to the Software Engineering Body of Knowledge. This course introduces software at an advanced level. Upon the successful completion of this course, students shall be able to:

1. Describe the software engineering management and quality processes, their purpose and importance
2. Apply advanced software engineering management techniques
3. Use appropriate methods and tools for the development and management of real world reliable software systems
4. Conduct yourself in an ethically responsible way expected of software professionals to ensure public safety

SC6115 - Introduction to Cyber Security

This course aims to equip students with practical security skills which can be applied in various business systems at risk. Students will get an in-depth understanding of common security concepts such as security goals, vulnerabilities, malware, threat models, access control and authentication. Students will also learn common practical issues and attack patterns including side-channel attacks, integer overflow, and code injection attacks. After finishing the course, students will also develop the ability to draft and strategize a cyber risk mitigation plan.

Specific topics include:

1. Cyber security fundamentals
2. Security model and threat modelling
3. Side-channel attacks and integer overflow
4. Authentication and Access control
5. SQL injection and Cross-Site Scripting attacks
6. Security testing

SC6116 - Game Theory and Blockchain

Game theory is a fundamental mechanism underlying blockchain technology. It is what allows cryptocurrencies such as Bitcoin to manage and divert disruptions to the network and ensure the reliability of distributed databases. This course aims at learners who want to understand the incentives and design mechanics of blockchains and blockchain-related problems.

The list of topics covered in this course are:

1. Introduction to Game Theory
2. Utility, Value and Price
3. Decision Theory
4. Basics of Game Theory
5. Coordination
6. The Problem of Selfish Behavior
7. Repeated Games and Sequential Games
8. Attacks on Proof of Work (PoW)
9. Attacks on Proof of Stake (PoS)
10. Fees in Blockchains
11. Auctions
12. Oracles
13. Principal-Agent Theory
14. Network Effects
15. Path Dependencies
16. Cooperative Game Theory
17. Social Choice
18. Application of Game Theory with Blockchain – Case Study

Course Details – Elective (Blockchain Management)

SC6121 - Token Economics

This module provides students with a fundamental understanding of blockchain technology and how it matters for financial markets. Students will be introduced to the following topics:

1. The overview of cryptocurrency and NFT markets
2. The economic theory and regulatory issues with these markets
3. The technical and practical matters related to these markets

This module will also provide practical drivers and parts of the token economy with examples of how value can be derived and what external factors to consider.

1. Security issues of the model and the technology
2. Drivers of value
3. New technologies as part of token economics

Specific topics include:

1. The overview of the cryptocurrency and NFT markets
2. Economic theory about the blockchain
3. Economic theory about contracts and smart contracts
4. Regulation issues about the token economy
5. The working mechanism of mining and trading in cryptocurrency markets
6. Programming and practical issues with smart contracts
7. Decentralization as the basis for tokens: Blockchain and other emerging technologies
8. Overview of Vulnerabilities: External and internal considerations
9. Monetisation of tokens
10. Value drivers of token economics
11. Designing an economic model with tokens

SC6122 - Emerging Topics in FinTech

The course aims to provide a critical understanding of fintech and disruption in the context of financial industry. It will cover the fintech developments in the fields of digital currencies, and etc using case studies of successful and unsuccessful firms. The course will also cover the practical applications of machine learning techniques to fintech use cases.

Specific topics include:

1. Critically understand the developments around digital currencies and cryptos and how they apply to the world of fintech
2. Understand the theoretical underpinnings of disruption
3. Develop an overview of fintech developments in the finance sector
4. Understand open banking (and the potential for open innovation)
5. Develop an understanding of machine learning techniques and their practical application to fintech
6. Critically assess the extent to which fintech has disrupted the financial system, the potential for future disruption and its limitations

SC6123 - Blockchain Business Applications

Blockchain will bring about huge changes to business. This technology will disrupt how enterprises are managed, how they create value, and even how they perform basic functions like marketing and accounting. In this course you will learn how blockchain technology can help the structures of organizations. You will explore how blockchain will transform the roles of the high level staff, and how a blockchain can be used to manage and protect intellectual property.

Specific topics include:

1. Understand how blockchain technology will transform business structures, roles, and functions of enterprise
2. Critically understand some strategic approaches to managing intellectual property with blockchain technologies

SC6124 - Ethics and Laws in Blockchain

This module provides a foundational understanding and appreciation of the legal and ethical issues and debates surrounding the use cases of Blockchain. It provides an overview of the current legal environment and the ethical concerns.

Some topics to be studied include:

1. Nature and limitations of Blockchain technology and appropriate use cases
2. Legal and smart contracts co-existence
3. Understand the legal and regulatory environments relevant to Blockchain
4. Understand the inherent legal risks of automated contracts
5. Anti-money laundering and Cryptocurrencies
6. ICOs and securities regulation
7. Blockchain technology structure: appropriate use cases
8. Blockchain technology: uniqueness and peculiarities within the context of law
9. Smart contracts and the legal and regulatory environments
10. Cryptocurrencies: ethics and laws

SC6125 - Blockchain in Finance

This course provides the foundation for developing new financial business models using blockchain technology. It is designed for students who are interested in the applications of blockchain in finance. You will learn the basics of blockchain technology and related practical topics, such as CBDC, crypto economics, DeFi, NFT, DAO, digital asset management.

Specific topics include:

1. Blockchain technology – characteristics of public, private, consensus algorithms, blockchain cryptography for distribution of trust and protection of privacy
2. Create smart contract on Ethereum network
3. Token Economics
4. Digital asset management and valuation analysis of the drivers of returns
5. CBDC, stablecoins
6. Decentralized Finance
7. Non-fungible Token
8. Decentralized Autonomous Organization

Course Details – Project

SC6131 - Blockchain Innovation Project

This course is a 3-6 month capstone project where students will have the opportunity to develop their own blockchain application, complete with a business and legal analysis. The project will be co-supervised by industrial experts through the Technical Fellowship Program.