C|BP Objectives

Students will be able to:

- Master the theoretical and technical foundations of blockchain technology.
- Understand the concept of decentralization, its impact, and its relationship with blockchain technology.
- Understand the underlying technical principles of blockchain development and implementation.
- Understand the blockchain technology mechanisms behind Bitcoin and other cryptocurrencies.
- Understand how cryptography is used to secure data with practical examples.
- Understand theoretical foundations of smart contracts and how Ethereum blockchain is used to develop decentralized applications using Solidity and relevant development frameworks.
- Investigate alternative blockchain solutions including Hyperledger, Corda, and many more.
- Discover use cases of blockchain powered applications in various industries.
- Explore blockchain implementation and commercialization strategies.
- Learn best practices for blockchain integration in current business architectures.
- Identify possible blockchain implementation implications on legal aspects.
- Predict adoption risks and failures from application strategies and learn how to avoid them with effective change management and project management approaches.
- Identify new research topics and the future scope of blockchain technology.

C|BP Modules

1. **Introduction: blockchain technology**

• Blockchain - the cornerstone of a decentralization strategy

• Decentralization

• Introduction to blockchain (history and evolution of blockchain through bitcoin)

• What fundamental issue blockchain resolves?

• Blockchain fundamentals

• What are blocks?

• What are transactions?

- Structure of a blockchain

- Elements of a blockchain

- Peer-to-peer network

- Hashing

- Byzantine generals problem

- Consensus algorithms

- Proof of work

- Proof of stake

- Distributed ledger technology (DLT)

- DLT vs blockchain

- Blockchain classification (public/private/permissioned or consortium blockchain networks)

- Blockchain as a transaction registry

- Advantages of blockchain

- Applications of blockchain

- Challenges towards blockchain adoption

- Future scope

2. Crypto assets
- What are crypto assets

- Tokenization

- Crypto-currencies, altcoins etc.

- Introduction to some cryptocurrencies (zcash, litecoin)

- Provisioning crypto assets, cryptocurrencies

- ICOs

- Token standards (ERC 20)

- Securitization of physical assets

3. Blockchain mining
- What is mining

- Why mining is performed / required?

- Different types of mining

- Solo mining

- Pool mining

- Hybrid mining

- Mining vs. Forging

- Design of a mining rig

- Problem of centralization

- Recent 51% attacks

4. Bitcoin

- Introduction

- History

- Ownership

- Bitcoin value - how is it determined?

- Bitcoin blockchain structure

- Components of the bitcoin network

- Mining and pow consensus

- Task of miners

- Transactions

- How transactions work in bitcoin

- Script language

- Utxo

- Financial investment and payments

- Exchanges

- Payment service provider

- Merchant acceptance

- Wallets

- Types of wallets

- Security and privacy

- Legality and taxation

- Bitcoin limitations

- Bitcoin variants

- Bitcoin clients

- Forking

5. Sustainable blockchain

- Mining

- Current bitcoin energy consumption

- Forecast

- How to address the energy consumption issue

- POS , alternate consensus algorithms

- Quantum Resistant Blockchain

6. Open source business blockchain frameworks

- Introduction

- Permissioned and permission less blockchain

7. Hyperledger

- History

- Projects

- Frameworks

- Burrow

- Fabric

- Indy

- Iroha

- Sawtooth

- Tools

- Cello

- Composer

- Explorer

- Quilt

- Caliper

8. Ethereum

- Introduction

- History

- Ether

- Performance (in comparison with bitcoin)

- Elements of the ethereum ecosystem

- Keys, address, accounts, calls, messages, world state, account state, transactions receipts, state storage, execution environment

- Clients (mist, geth)

- Ethereum virtual machine

- Execution environment, machine state, iterator function.

- Smart contracts

- Introduction

- History

- How do smart contracts work?

- Advantages

- Implementation

- Solidity language

- Writing smart contracts

- Supporting protocols

- Whisper and swarm

- Benefits

- Challenges

9. Decentralized applications (DApps)

- DOs, DAOs

- Decentralized autonomous organization (DAOs)

- Introduction

- Structure and operation

- Security

10. AI and Blockchain

- What is AI

- What is machine learning

- Convergence of AI with blockchain

- Machine learning and blockchain

- Intelligent smart contracts

- Examples

- DAOs and AI

- Blockchain X.0

11. Impact on industry

- Financial

- Insurance

- Government

- Technology

- Media

- Healthcare

- Others

12. Industry use cases

- Sample use cases

- Supply chain – food supply chain

- Identity management

- Identity and blockchain

- What is identity

- Identity on blockchain

- Examples

- Advantages

- Design of a blockchain based identity solutions

- Other use cases

- Distributed storage

- Post trade clearance

13. IOT and blockchain

- Blockchain of things

- Usual /normal IOT model vs blockchain based IOT model

- Advantages of IOT and blockchain convergence

- How to achieve convergence

- Examples

14. Blockchain project implementation

- Creating networks

- Types of networks

- How to build a private networks (Ethereum)

- Solidity language in detail

- Types, literals, functions, variables, controls structures

- Examples using remix IDE

- Writing smart contract code

- Tools and frameworks for smart contract development on ethereum

- Remix IDE

- Web3.Js

- Metamask

- Truffle

- Ganache

- Wallets / clients

- Monitoring blockchain network (block explorer)

- Real-world project

- Write a proof of idea (patent application)

- Get help and support

- Get involved

15. Scalable Blockchain

- What is the scalability issue?

- How scalability issues can be solved

- What has been done so far

- What are the possible solutions, sharding, off chain etc?

- A survey of advanced techniques for blockchain scalability

- Examples of recent bitcoin scalability solutions

- Other advanced and new protocols such as chainweb etc

- Layer 2 solutions (off chain solutions), lightning etc

- Consensus performance

16. Security in blockchain (Secure Blockchain)

- Secure smart contracts

- Vulnerabilities in smart contracts

- How to mitigate

- Formal verification of smart contracts

- Other security issues and mitigation

- End point security

- Privacy and confidentiality

17. Blockchain as a service (BAAs)

- Microsoft azure

- IBM blockchain service

- Others

18. Open research problems in blockchain

• Interoperability

• Security

• Privacy

• Performance

• Scalability

• Standardization (ISO TC 307)