Unit-4

Q ▶ **Blockchain** :- Blockchain is a secure digital system that stores data in blocks linked together, and once data is stored, it cannot be changed.

Blockchain is a distributed and decentralized digital ~~leg~~ ledger that records transactions in the form of blocks linked together in a chronological and secure chain.

In simple words :-
Blockchain = Digital record book that cannot be easily changed or hacked.

Blockchain is a digital record book where information is stored safely and permanently.
- Instead of one person or company controlling the record,
- many computers share the same record

That is why blockchain is called decentralized.

Structure of Blockchain

Blockchain is made up of blocks, and these blocks are linked together to form a chain.

What is block?

A block is like a page in a record book. Each block stores important information.

Main parts of a Block :-

Each block in a blockchain has four main parts :-

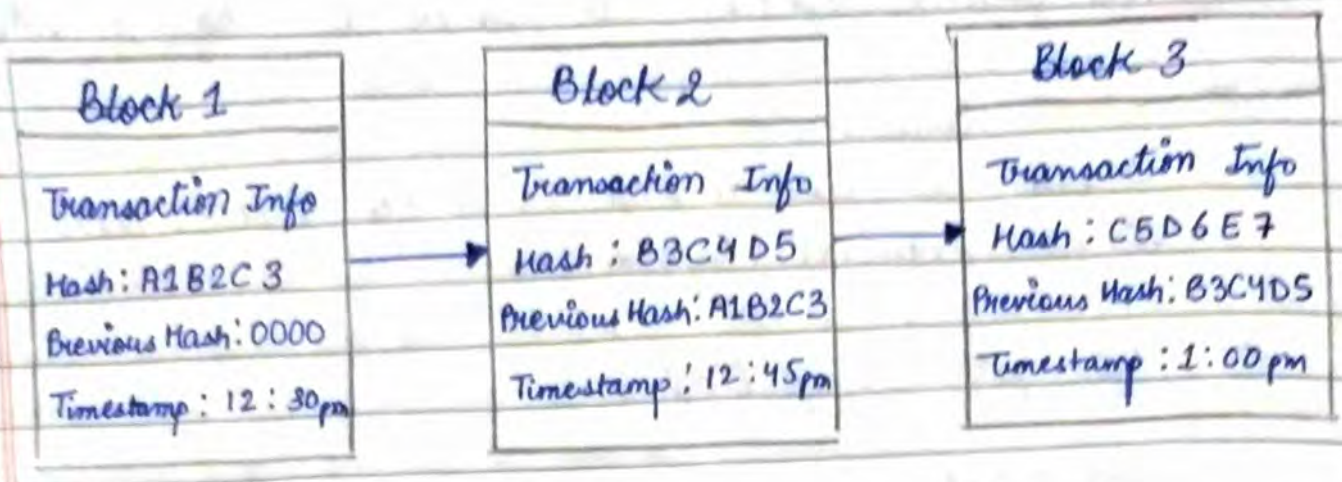
(1.) Data
- Stores the actual information or transaction details.
- Example : sender, reciever, amount etc.

(2.) Hash
- A unique code created for each block
- Works like a digital fingerprint
- If data changes the hash also changes.

(3.) Previous Hash
- Stores the hash of the previous block
- This connects one block to another and forms a chain.

(4.) Timestamp
- Records the data and time when the block was created.

* Diagram of Blockchain structure.



↳ Features of Blockchain

1. Decentralization
   - There is no single owner or central authority.
   - Data is stored on many computers (nodes) in the network.

2. Security
   - Blockchain uses cryptography (hashing) to protect data
   - It is very difficult to hack or alter information

3. Immutability
   - Once data is stored in a block, it cannot be changed, or deleted.
   - This makes blockchain tamper-proof.

4. Transparency
   - All transactions are visible to all participants in the network.
   - This increases trust among users.

5. Distributed ledger
- Every participant has a copy of the same data.
- If one system fails, data is still safe on others

6. Trustless System
- Users do not need to trust each other.
- Trust is created by technology and rules, not people.

7. Traceability
- Every transaction can be tracked from start to end.
- Very useful in supply chain management

8. Consensus Mechanism
- Transactions are added only after network agreement.
- Ensures data is valid and verified.

Ans: Advantages of Blockchain

(i) High security
(ii) Transparency
(iii) Data Immutability
(iv) Decentralization
(v) Reduced Cost
(vi) Traceability

Q) Disadvantages / Limitations of Blockchain

1.) High Energy Consumption
- mining and validation consume a lot of power

2.) Scalability Issues
- Handles fewer transactions per second
- Becomes slow as network grows

3.) Storage Problems
- each node stores a copy of the blockchain
- Requires large storage space

4.) Slow Transactions
- Verification Process Takes Time
- Slower than traditional databases

5.) Legal and Regulatory Issues
- Laws related to Blockchain are still unclear in many countries

6.) Irreversible Data
- Mistakes cannot be corrected once data is added

Application Areas of Blockchain

(1.) Cryptocurrency
- Blockchain is used to create & manage digital currencies.
- Transactions are secure and do not require banks.

Example : Bitcoin, Ethereum

(2.) Banking and Finance
- Used for secure money transfer, payments, and settlements.
- Reduces fraud and transaction time

Uses : International money transfer, Digital payments, Fraud Detection

(3.) Supply Chain Management
- Tracks products from manufacturer to customer
- Ensures transparency and authenticity.

(4.) Healthcare
- Stores patient medical records securely
- Data cannot be altered without permission

(5.) Voting System
- Used for secure and transparent online voting
- Prevents vote Tampering and fraud

(6.) Smart contracts
- Automatically executes agreements when conditions are met.
- No need for intermediaries.

(7.) Digital Identity
- Used to create secure digital IDs
- Prevents identity theft

(8.) Education
- Stores certificates and academic records securely
- Prevents fake degrees

(9.) Real Estate
- Used in property registration and ownership transfer
- Reduces paperwork and fraud.

Fundamentals of Blockchain

(1.) Blockchain :- Blockchain is a secure digital record system where data is stored in blocks and these blocks are linked together to form a chain. Once a data is stored, it cannot be changed.

(2.) Block :- A block is a unit that stores information. Each block contains :
- Data (transaction details)
- Hash (Unique code of the block)
- Previous Hash (link to previous block)
- Timestamp (date and time)

(3.) Chain :- Blocks are connected using previous hash, forming a chain.
- If one block is changed, the whole chain breaks.

(4.) Decentralization :- • Block chain does not have a central authority.
• Data is stored on multiple computers or nodes
• Every node has the same copy of data

(5.) Distributed Ledger :- • A ledger is a record book.
• Blockchain ledger is distributed, meaning copies are shared across the network
• Ensures data safety and transparency

(6.) Hashing :- • Hash is a unique digital fingerprint
• Any change in data changes the hash
• Protects blockchain from tampering.

(7.) Consensus Mechanism :- • Transactions are added only after agreement of the network.
• Ensures only valid transactions are recorded.

(8.) Immutability :- • Data once stored cannot be modified or deleted
• Prevents fraud and manipulation

(9.) Transparency :- • All transactions are visible to network participants.
• Builds trust among users.

Q. Cryptocurrencies: Cryptocurrency is a digital or virtual currency that is used for online transactions and is secured using cryptography.

It works on blockchain technology and does not require a central authority like a bank.

In simple words:

Cryptocurrency = Digital money used on the Internet.

Q. Cryptography: Cryptography is the technique of protecting information by converting it into a secret code so that only authorized people can read or access it.

In simple words:

Cryptography = Hiding information safely

Or

Cryptography is the process of securing information by converting it into an unreadable form using encryption techniques so that only authorized users can access it.

Q. How Cryptocurrency Works: Cryptocurrency works using blockchain technology, cryptography, and a decentralized network of computers.

Step 1: User Initiates a Transaction

- A user sends cryptocurrency (like Bitcoin) to another user

Step 2: Transaction is Broadcast to the Network
- The transaction is sent to peer-to-peer (P2P) network
- This network consists of many computers called nodes.

Step 3: Verification of Transaction
- Nodes verify the transactions by checking:
  - Is the sender's wallet valid?
  - Does the sender have enough balance?
  - Is the transaction authentic?

This verification uses cryptography and digital signatures.

Step 4: Transaction is Grouped into a Block
- Verified transactions are collected together.
- These transactions form a block.

Step 5: Mining / Validation
- special nodes are called miners (or validators) compete to add the block to the blockchain.
- They solve complex mathematical problems (Proof of work)

The first miner to solve it, gets a reward.

Step 6: Block is Added to Blockchain
- The new block is linked to the previous block using a hash.
- Once added, the data becomes permanent and cannot be changed.

Step 7: Transaction is Completed
- The blockchain is updated across all nodes
- The reciever gets the cryptocurrency.
- The transaction is now confirmed and secure.

Features of Cryptocurrency

1. Digital Currency
   - Cryptocurrency exists only in digital form.
   - No physical coins or notes.

2. Decentralized
   - Not controlled by any bank or government
   - Works on a peer to peer network.

3. Secure
   - Uses cryptography and blockchain technology
   - Very difficult to hack or tamper with transaction

4. Transparent
   - All transactions are recorded on a public blockchain
   - Anyone can verify transactions.

5. Limited Supply
   - Many cryptocurrencies have a fixed maximum supply
   - Example : Bitcoin has a limit of 21 million coins.

6. Fast Transactions
   - Transactions are completed quickly, even across countries.

7. Low Transaction Cost
   - No middlemen like banks, so fees are low.

8. Global Accessibility
   - Can be used anywhere in the world with internet access.

Types of Cryptocurrency

Cryptocurrencies can be classified into four main types based on their purpose and use.

1. Bitcoin
   - The first & most popular cryptocurrency.
   - Introduced in 2009
   - Mainly used as digital money and store of value

2. Altcoins (Alternative coins)
   - All cryptocurrencies other than Bitcoin
   - Created to improve or add new features

   Examples :
   - Ethereum (ETH)
   - Litecoin (LTC)
   - Ripple (XRP)
   - Cardano (ADA)

3. Stablecoins
   - Cryptocurrencies whose value is stable.
   - Usually linked to real-world assets like USD or gold.
   - Purpose : Reduce price fluctuation

   Examples : Tether (USDT), USD coin (USDC)

4. Tokens
   - Created on existing blockchain platforms
   - Used for specific purposes like access, voting, or rewards.

   examples :
   - Chainlink (LINK)
   - Uniswap (UNI)

Applications of Cryptocurrency.

1. Online Payments
   - Used to pay for goods and services online.
   - Fast and secure transactions without banks.
   Ex: Paying on international websites using Bitcoin.

2. International Money Transfer
   - Used to send money across countries quickly
   - Lower cost compared to traditional banks.

3. Investment and Trading
   - People buy and sell cryptocurrency to earn profit.
   - Act as a digital investment asset.

4. E-commerce
   - Many online stores accept cryptocurrency as a payment method.
   - No need for credit/debit card.

5. Smart Contracts
   - Cryptocurrency platforms like Ethereum support smart contracts
   - Automatically execute agreements when conditions are met.

6. Decentralized Finance (DeFi)
   - Used in banking services without banks
   - Includes lending, borrowing, and saving money digitally.

7. Donations & Charity
- Used for secure and transparent donations.
- Helpful during emergencies and disaster relief.

8. Gaming and Digital Assets
- Used to buy in-game items, NFTs & digital rewards
- Supports virtual economy

9. Secure storage of value
- Used as digital gold to store wealth
- Protects against inflation in some cases.

Q► Cloud Computing ← Cloud computing is a technology that allows users to store, manage, and access data, software, and services over the Internet instead of using a local computer or physical server.

In simple words:
cloud computing = using internet-based services instead of your own computer storage

Q► How cloud computing works ←
Instead of storing data and running software on your own computer, cloud computing uses powerful remote servers (in data centers) that you access through the internet.

Step-by-step working ←

1. User makes a request
   - You open a website or app.
   - This request goes from your device to the cloud through internet.

2. Internet connects you to cloud servers

3. Cloud processes the request
   - Cloud server runs the required software
   - Fetches or stores data
   - Performs calculations if needed.

4. Results are sent back

5. You can pay for what you used.

Key components involved :-
- Client device : laptop, mobile, tablet
- Internet : connects user to cloud
- Cloud servers : Do all processing and storage
- Data centers : Physical locations of servers
- Cloud software : Apps and services you use.

Types of cloud computing services :-

1. IaaS (Infrastructure as a service)
   - Provides virtual machines, storage, and networks
   - Example : Amazon EC2

2. PaaS (Platform as a service)
   - Provides platforms for developers to build applications
   - Example : Google App Engine

3. SaaS (Software as a service)
   - Provides ready-to-use software over the internet
   - Example : Gmail, Google Docs, Zoom

Deployment Models of Cloud :-

- Public Cloud - Open to public (AWS, Google Cloud)
- Private cloud - Used by one organization
- Hybrid Cloud - Combination of public and private cloud.

Q. Nature / Characteristics of Cloud computing

(1.) On-Demand Service
Users get storage, servers, or apps whenever needed, without human interaction.

(2.) Internet-based Access
Services are accessed through the Internet from anywhere, anytime.

(3.) Scalability
Resources can be increased or decreased easily as per requirement.

(4.) Pay-As-You-Use
Users pay only for what they use, not for unused capacity.

(5.) Resource Sharing (Multi-Tenancy)
A single cloud infrastructure is shared by many users securely.

(6.) High Availability
Services are designed to be available most of the time with backups.

(7.) Automatic Updates
Software and systems are updated automatically by the provider.

Q. Benefits of cloud computing

1. Cost Saving
No need to buy hardware or maintain servers → lower cost

2. Anywhere Access

3. Scalability & Flexibility

4. Automatic Backups & Recovery

5. High Performance
Uses powerful servers → fast processing & storage

6. Easy Maintainance

7. Collaboration
Multiple users can work together on the same data in real time.

Q. Cloud Service Provider
A cloud service provider is a company or organisation that offers cloud computing services such as storage, servers, software, and platforms over the Internet.

Examples of Cloud Service Providers :
- Amazon Web services (AWS)
- Microsoft Azure
- Google cloud Platform (GCP)
- IBM cloud
- Oracle cloud

AWS - Amazon Web Services

AWS is the largest and most popular cloud platform, offered by Amazon.

It offers :
- Virtual servers (EC2)
- Storage (S3)
- Databases, networking, AI tools

Why it's used :
- very reliable & scalable
- used by startups to large companies

Examples of users : Netflix, Amazon, startups

GCP - Google Cloud Platform

GCP is Google's cloud platform.

What it offers :
- virtual machines
- Big data & analytics
- AI / ML services

Why it's used :
- excellent performance
- best for data analytics and machine learning

examples of users : Youtube, Spotify

Ans IBM cloud

IBM cloud is an enterprise-focused cloud by IBM

What it offers :
- Cloud + AI (Watson)
- Hybrid Cloud Solutions
- Strong security services

Why it's used :
- Trusted by banks & enterprises
- Good for legacy systems

Example of users :- Banking and enterprise companies

Ans Microsoft Azure

Microsoft Azure is a cloud platform by Microsoft

What it offers :
- Virtual Machines
- Cloud storage
- Integration with windows, Office, .Net.

Why it's used :
- Best for Windows-based applications
- Easy integration with microsoft tools